perform memory management, thus it can flexibly perform a plurality of search types using a single hardware set.

Still another object of the present invention is to provide a bit string check method and device wherein an increase in the length of a bit string (key) to be searched can be coped with by adding a unit or repeating a series of processes without the need for an algorithmic change of hardware.

DISCLOSURE OF THE INVENTION

In a bit string check method of the present invention, there is employed a method including the process of dividing a bit string to be searched into a plurality of partial-object bit strings (partial bit string to be searched), and comparing at respective stages with a plurality of bit patterns registered in advance. A current stage which is one of the check stages included in the multiple stages comprises: an all-check step of selecting a partial-object bit string of the current stage from the bit string to be searched and comparing it with all possible values of a partial-object bit string of the current stage; and a pattern loading step of loading a pattern table of the current stage from a memory independently of the all-check step before, after or in parallel with the all-check step, the pattern table being for indicating a partial registration bit pattern of each of the

plurality of registration bit patterns, the pattern table being determined by check-continuation information received from a stage preceding the current stage. The pattern table of the current stage has a range corresponding to all possible values of a partial-object bit string of the current stage, and represents partial registration bit patterns to be compared with the partial-object bit string of the current stage.

The current stage further comprises a judgment step of obtaining a check result indicating at least a presence or absence of the partial registration bit pattern of the current stage which matches the partial-object bit string of the current stage in accordance with the result of the all-check step and the pattern table of the current stage; and an outputting step of outputting check-continuation information including the address of a pattern table of the stage subsequent to the current stage from an address table corresponding to the pattern table of the current stage in accordance with the check result.

The address table represents the address of the pattern tables of the next stage subsequent to respective partial registration bit patterns on the pattern table of the current stage. Thus, from the address table, it is possible to output check-continuation information including the address of the pattern table of the next stage indicating a partial registration bit pattern to be checked in the next stage, subsequent to the matched partial

registration bit pattern in the current stage.

As a check device for realizing the above check method, in the present invention, there is provided a check device for executing at lease one stage included in multiple stages so as to check against a plurality of bit patterns registered in advance at the multiple stages with dividing a bit string to be searched into a plurality of partial-object bit strings. The check device comprises all-check means for selecting a partial-object bit string of the current stage from the bit string to be searched and for comparing the partial-object bit string of the current stage with all possible values of a partial-object bit string of the current stage; pattern loading means for loading a pattern table of the current stage from a memory independently of the all-check means, the pattern table being for indicating a partial registration bit pattern of each of the plurality of registration bit patterns, the pattern table being determined by check-continuation information received from a stage preceding the current stage; judgment means for obtaining a check result indicating at least a presence or absence of the partial registration bit pattern of the current stage which matches the partial-object bit string of the current stage in accordance with the result of the all-check means and the pattern table of the current stage; and outputting means for outputting check-continuation information including the

partial-object bit string. On the other hand, the minimum partial registration bit pattern closest to the value of the partial-object bit string means a partial registration bit pattern that has the smallest value of partial registration bit patterns larger than the partial-object bit string. In accordance with the selection of the address of the pattern table subsequent to the maximum partial registration bit pattern, a right-inclined scope search to be described later is enabled. Further, in accordance with the selection of the address of the pattern table subsequent to the minimum partial registration bit pattern, a left-inclined scope search to be described later is enabled. Hence, in the searching of the right-inclined type, the maximum side to be described later is selected, and in the searching of the left-inclined type, the minimum side to be described later is selected.

Further, in the check method and check device of the present invention, at one stage (current stage) of the multiple check stages, comparison is made with all the possible values of a partial-object bit string by the all-check step and all-check means. Therefore, it is possible to load the pattern table of the current stage indicating the partial registration bit pattern (hereinafter, also referred to as an 'entry') of the current stage, to be object compared with the partial registration bit pattern of the current stag, from a memory with the process independent of the check, and lead a complete match or a scope match.

The pattern table does not need to be a bit string of
a partial entry, but, from the viewpoint of data amount, is
preferably data representing the value of the partial entry
directly or using a bit pattern or a flag in a form
corresponding to the partial entry. The present invention
comprises the all-check step or all-check means for
comparing all the possible values of a partial-object bit
string. Hence, when executing the all-check, within the
values to be compared, the pattern table can be given as
mask data consisting of a bit flag indicating a validness or
invalidness of the partial registration bit pattern. That is,
in the all-check, since the range of the possible values of
a partial-object bit string is fixed in advance, it is
possible to store the pattern table in the memory as such
mask data and to load it from the memory. Hence, in the
pattern loading step and means, the mask data is loaded from
a memory.

Further, in this check method and device, as a
comparison is made between all the possible values of a
partial-object bit string, an amount or area capable of
covering all the possible values of a partial-object bit
string is secured in advance as the amount or area of the
pattern table. Hence, when an entry is added, this is
enabled simply by updating a mask pattern, and an entry

shift caused by the addition and deletion of an entry does not occur. For this reason, the overhead of table management using a higher order application can be reduced or eliminated. Therefore, it is possible to provide a bit string check method and device which reduces a load on higher order application software even in packet filtering or stateful packet inspection.

Especially, in the case of the mask data, since it is possible to represent one entry by one bit, the storage capacity of the pattern table is reduced to a large extent, and the pattern table loading time is reduced. Further, even in updating, the number of bits to be rewritten in the process of addition and deletion of an entry is reduced to a large extent, the processing is simplified, and the processing time is also reduced. Therefore, it is effective to make the pattern table into mask data.

The process (all-check step and means) of performing comparison with all the possible values of a partial-object bit string is an independent process, and therefore is executable rapidly by hardware utilizing a comparator or lookup table, and the scale of hardware does not also increase by dividing the process into multiple stages. Although the bit length of the partial-object bit string is not limited, the hardware becomes larger if the bit length is increased, and the number of stages of checking is increased if the bit length is decreased. The

appropriate scale of hardware changes in dependence on the purpose which the hardware will serve, the hardware's economic value, realizable wiring rules, etc. Currently, it is considered to be preferable that the bit length of the partial-object bit string is about 4 or 5 bits. In addition, it is unnecessary to change hardware algorithmically with an increase in bit length of a retrieved bit string (hereinafter, also referring to as a key) to be searched, and the above increase can be coped with by adding a unit or repeating a series of processes.

The check method and check device of the present invention have a remarkable effect in that they can be sped up by simple configuration. Firstly, the all-check step and the pattern loading step are independent of each other, and therefore they can be executed in parallel, and the overhead time, generated from the division into multiple stages, of loading the pattern table from a memory can be reduced to a large extent. Thus, it is possible to provide a check method and device which, without employing a memory of a high speed of a specific structure, exhibit a sufficiently high searching speed, are cheap and implement large capacity searching at a high speed. Such a check device exhibits high scalability and can perform memory management flexibly since the number of acceptable entries is limited only by the SDRAM capacity. Hence, a plurality of search types can be performed flexibly using a single hardware set.

bit string to be searched, and with regarding data indicating a plurality of state transition conditions as the plurality of registration bit patterns; and a step of transiting states of a data processing circuit in accordance with a check result of the check step.

According to the present invention, it is possible to provide a data processing device, comprising: a check device for checking a bit string to be searched of a current state forming an evaluation source of a state transition against a registration bit pattern indicating a plurality of state transition conditions registered in advance; search object provision means for providing the bit string to be searched to the check device; and a data processing circuit whose state is transited in accordance with an output of the check device. This data processing device is a transition state machine or an automaton processor, which can be also called a classification processor. In this case, the check device comprises: all-check means for comparing all possible values of a bit string to be searched in a current stage; pattern loading means for loading a pattern table of the current state from a memory independently of the all-check means, the pattern table being for indicating the plurality of registration bit pattern, the pattern table having a range corresponding to all possible values of a partial-object bit string of the current stage, the pattern table being determined by check-continuation information obtained from a preceding stage; judgment means for outputting a check result indicating at least a presence or absence of

What is claimed is:

1. A bit string check method including a process of checking against a plurality of bit patterns registered in advance at multiple stages with dividing a bit string to be searched into a plurality of partial-object bit strings,

wherein a current stage being one check stage included in the multiple stages, comprising:

an all-check step of selecting a partial-object bit string of the current stage from the bit string to be searched and comparing the partial-object bit string of the current stage with all possible values of a partial-object bit string of the current stage;

a pattern loading step of loading a pattern table of the current stage from a memory independently of the all-check step before, after or in parallel with the all-check step, the pattern table being for indicating a partial registration bit pattern of each of the plurality of registration bit patterns, the pattern table having a range corresponding to all possible values of a partial-object bit string of the current stage, the pattern table being determined by check-continuation information received from a stage preceding the current stage;

a judgment step of obtaining a check result indicating at least a presence or absence of the partial registration bit pattern of the current stage which matches the partial-object bit string of the current stage in accordance with the result of the all-check step and the pattern table of

string of the current stage from the bit string to be searched and for comparing the partial-object bit string of the current stage with all possible values of a partial-object bit string of the current stage;

pattern loading means for loading a pattern table of the current stage from a memory independently of the all-check means, the pattern table being for indicating a partial registration bit pattern of each of the plurality of registration bit patterns, the pattern table having a range corresponding to all possible values of a partial-object bit string of the current stage, the pattern table being determined by check-continuation information received from a stage preceding the current stage;

judgment means for obtaining a check result indicating at least a presence or absence of the partial registration bit pattern of the current stage which matches the partial-object bit string of the current stage in accordance with the result of the all-check means and the pattern table of the current stage; and

outputting means for outputting check-continuation information including the address of a pattern table of the stage subsequent to the current stage from an address table corresponding to the pattern table of the current stage in accordance with the check result.

22. The check device according to claim 21, wherein the pattern table is mask data consisted of a bit flag indicating a validness or invalidness of the partial

wherein the check table provided to the first check device is determined by the output of the classification device or the searching object provision means.

48. The data processing device according to claim 47, wherein the memory stores a check table including the pattern table and the address table, and the check table of the memory is rewritten by the data processing circuit.

49. A data processing device, comprising:

a check device for checking a bit string to be searched of a current state forming an evaluation source of a state transition against a registration bit pattern indicating a plurality of state transition conditions registered in advance;

search object provision means for providing the bit string to be searched to the check device; and

a data processing circuit whose state is transited in accordance with an output of the check device,

wherein the data processing device further comprises:

all-check means for comparing all possible values of a bit string to be searched in a current stage;

pattern loading means for loading a pattern table of the current state from a memory independently of the all-check means, the pattern table being for indicating the plurality of registration bit pattern, the pattern table

having a range corresponding to all possible values of a partial-object bit string of the current stage, the pattern table being determined by check-continuation information obtained from a preceding stage;

judgment means for outputting a check result indicating at least a presence or absence of the registration bit pattern of the current state which matches the bit string to be searched of the current state in accordance with the result of the all-check means and the pattern table of the current state of the all-check means; and

outputting means for outputting check-continuation information including the address of the pattern table of the next state subsequent to the current state in accordance with the check result.

50. The data processing device according to claim 49, wherein the memory stores a check table including the pattern table and the address table, and the check table provided to the check device is determined by the searching object provision means.

51. The data processing device according to claim 49, wherein the memory stores a check table including the pattern table and the address table, and the check table of the memory is rewritten by the data processing circuit.

52. The check method according to claim 1, wherein, in the all-check step, the check is performed by hardware employing a comparator or a look-up table.

53. The check device according to claim 21, wherein the all-check means performs the check with hardware employing a comparator or a look-up table.

54. The data processing device according to claim 49, wherein the all-check means performs the check with hardware employing a comparator or a look-up table.